

SEPTEMBER 2019



**WIM #42
US 61,
MP 119.6
COTTAGE
GROVE,
MINNESOTA**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #42 is located on US 61 near Cottage Grove in Washington county.

System Operation

WIM #42 was operational for the entire month of September 2019. Volume was computed using all monthly data.

System Calibration

WIM #42 was most recently calibrated on 2019-05-13. Table 1 summarizes the front axle weights of class 9s by lane ¹. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation ². Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 1078795 | Passenger Vehicles: 1024635 | Heavy Commercial Vehicles: 54160

Monthly Average Daily Traffic (MADT): 36258 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1805

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 54160 HCVs, 7182 of them were overweight ³. These overweight HCVs contributed to 0.7% of total monthly volume, and 13.6% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 67% of all overweight vehicles traveling SB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in June.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report ⁴.

Using normal load limits ,152 NB vehicles exceeded 88,000 pounds (92 vehicles were Class 9's; 40 vehicles were Class 13's). Of vehicles traveling SB,

748 NB vehicles exceeded 88,000 pounds (550 vehicles were Class 9's; 101 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in September 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling NB, while there were more empty Class 9's than fully_loaded traveling SB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 392359 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (53.6%) than NB (46.4%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 5895 (Hastings Bridge) is approximately 1.9 miles south of WIM #42, and Bridge No. 82J16 is 1.0 miles north of WIM #42. WIM #42 recorded a total of 1078795 vehicles with a combined GVW of 6551598 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 37482 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 58.5% of all ESALs were recorded SB while 41.5% was observed NB. In particular, 60% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 16% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:

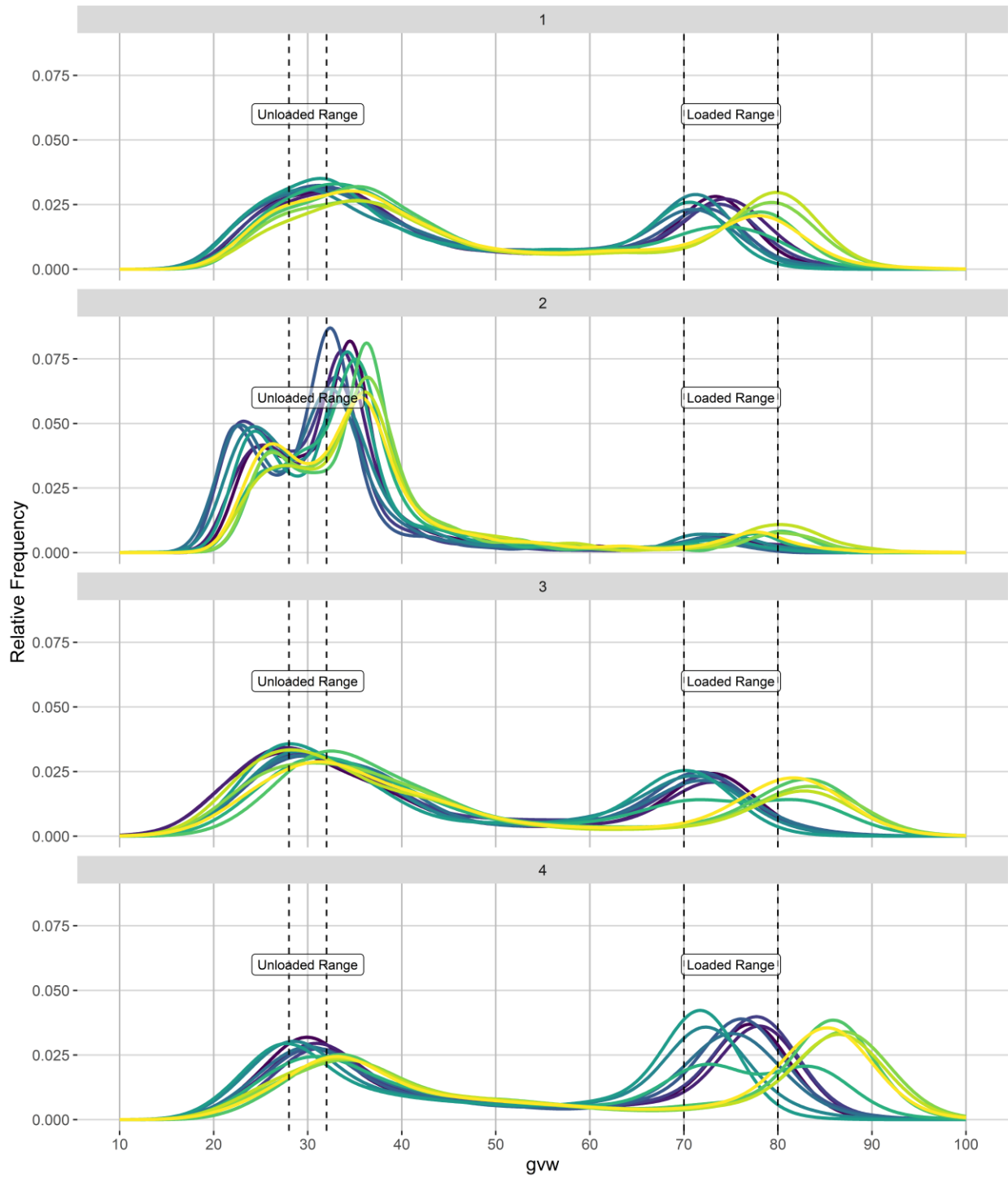
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at:
<http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ±9% of baseline calibration values
- ² Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- ³ An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes:
http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp
- ⁴ For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Figure 1 - Monthly Class 9 GVW Histogram

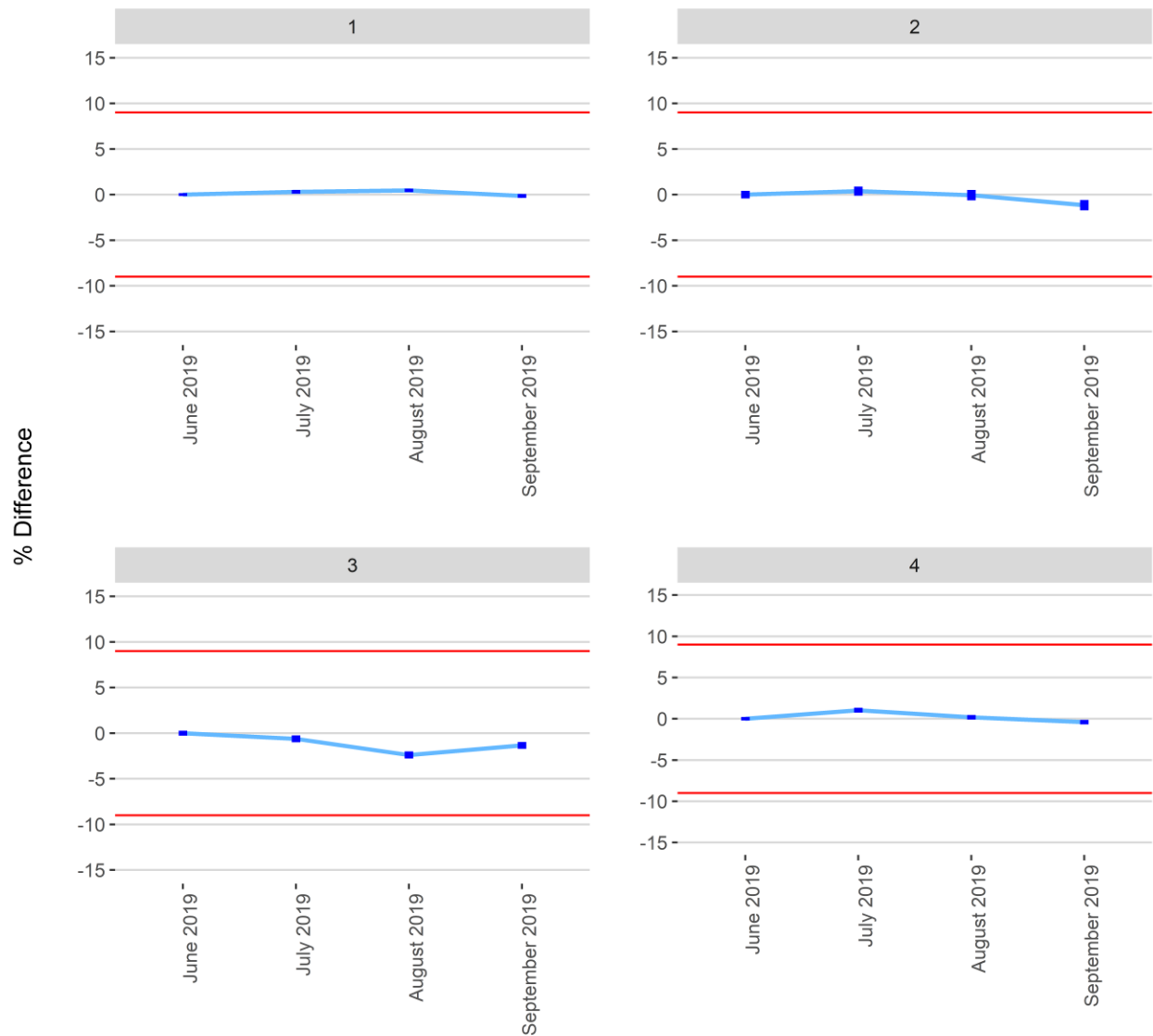


Time

October 2018	January 2019	April 2019	July 2019
November 2018	February 2019	May 2019	August 2019
December 2018	March 2019	June 2019	September 2019

Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume
vs. Day of the Week

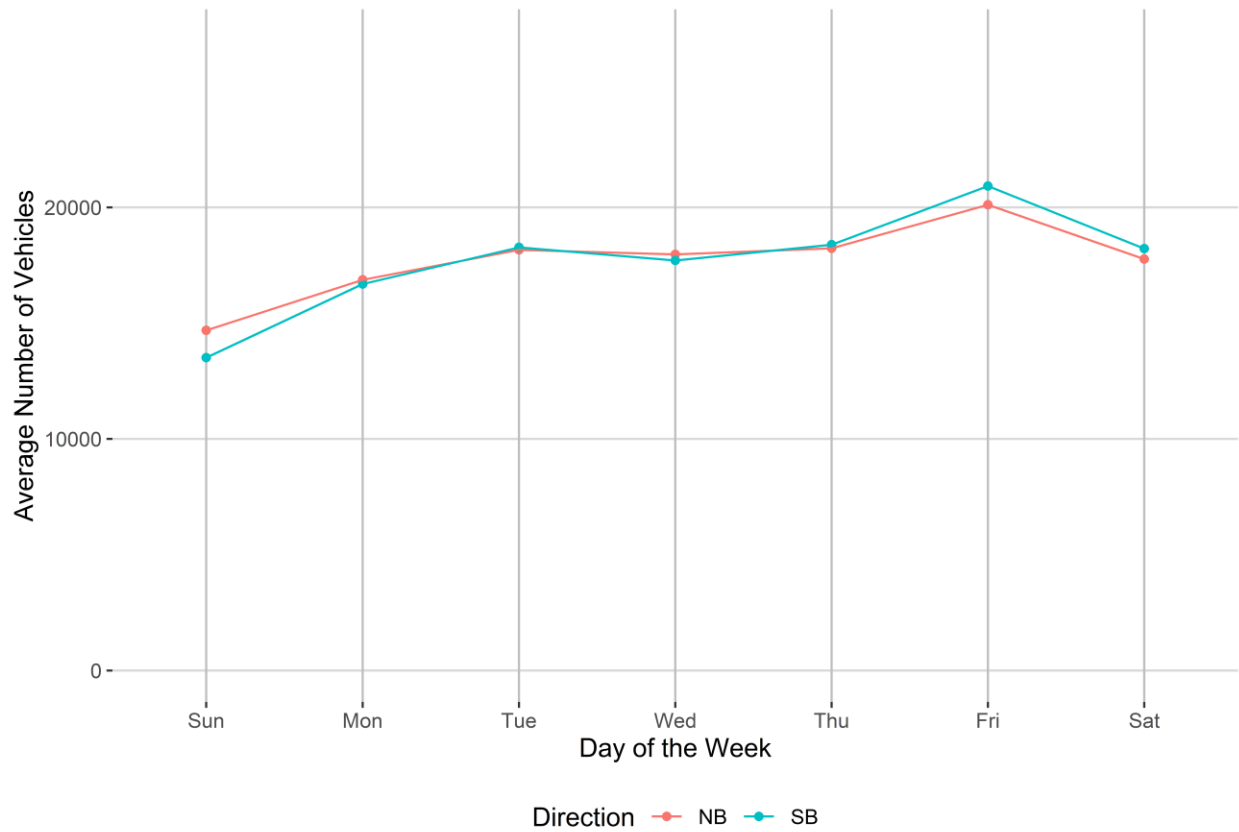


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

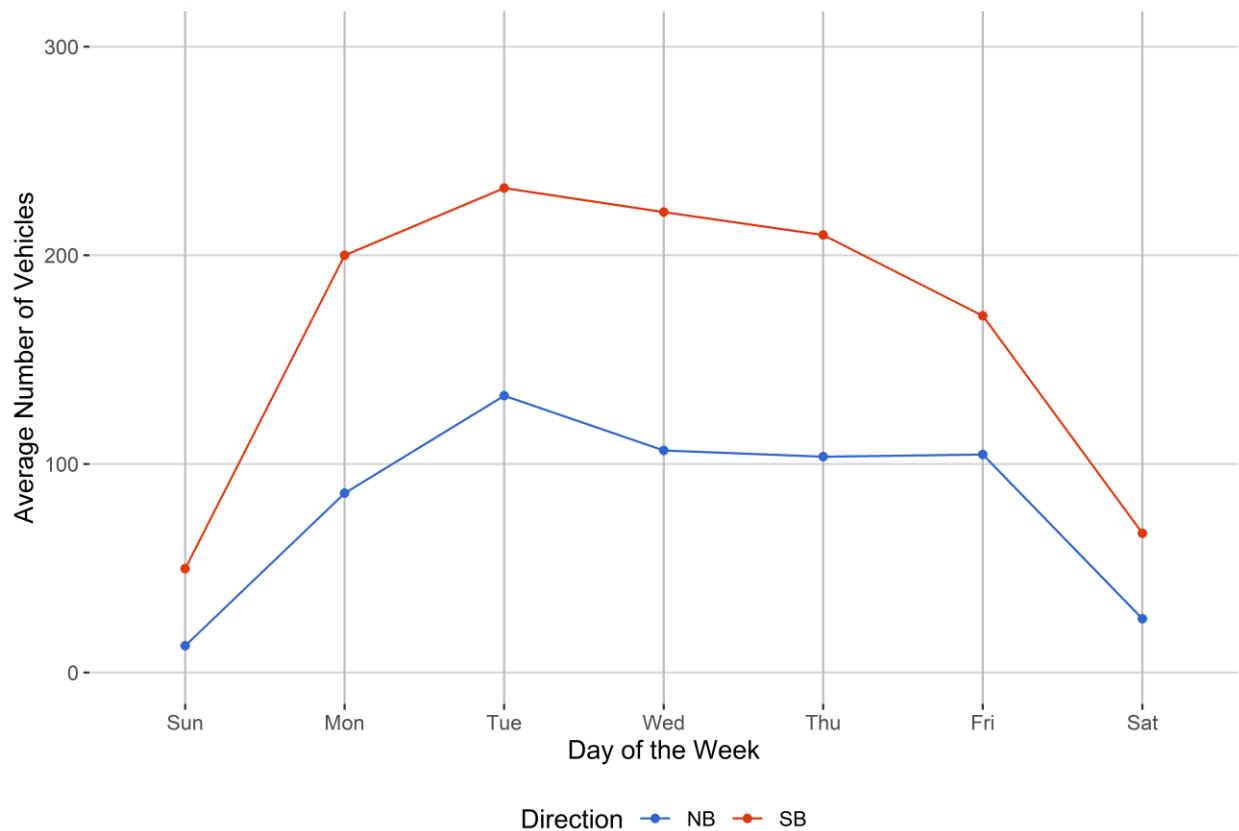


Figure 4 - Passenger Vehicles
vs. Hour of the Day

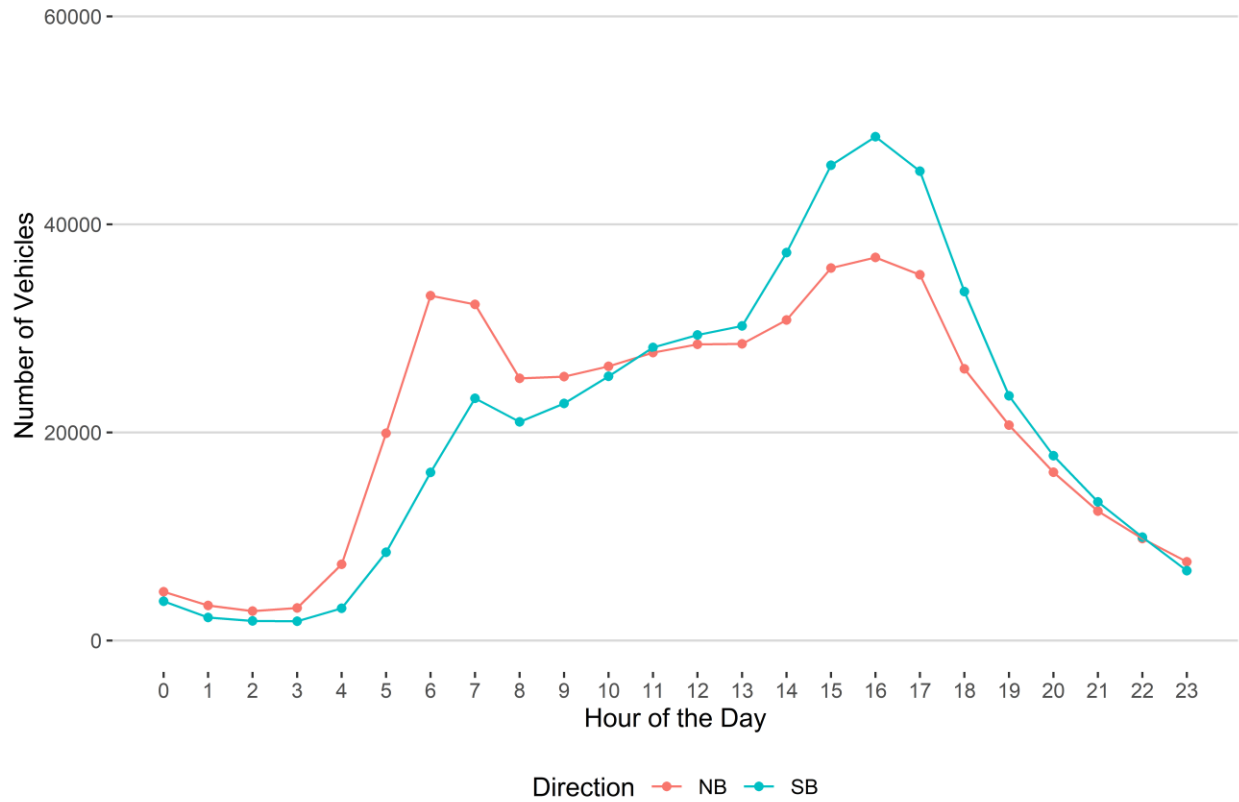


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

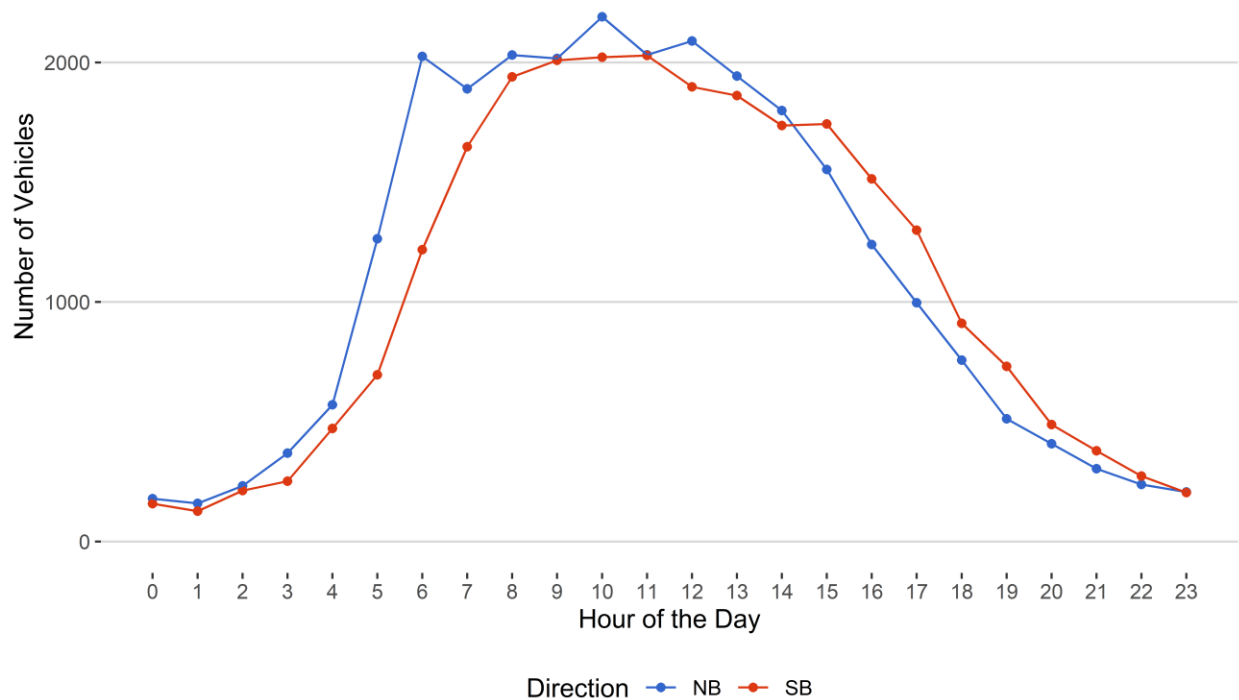


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

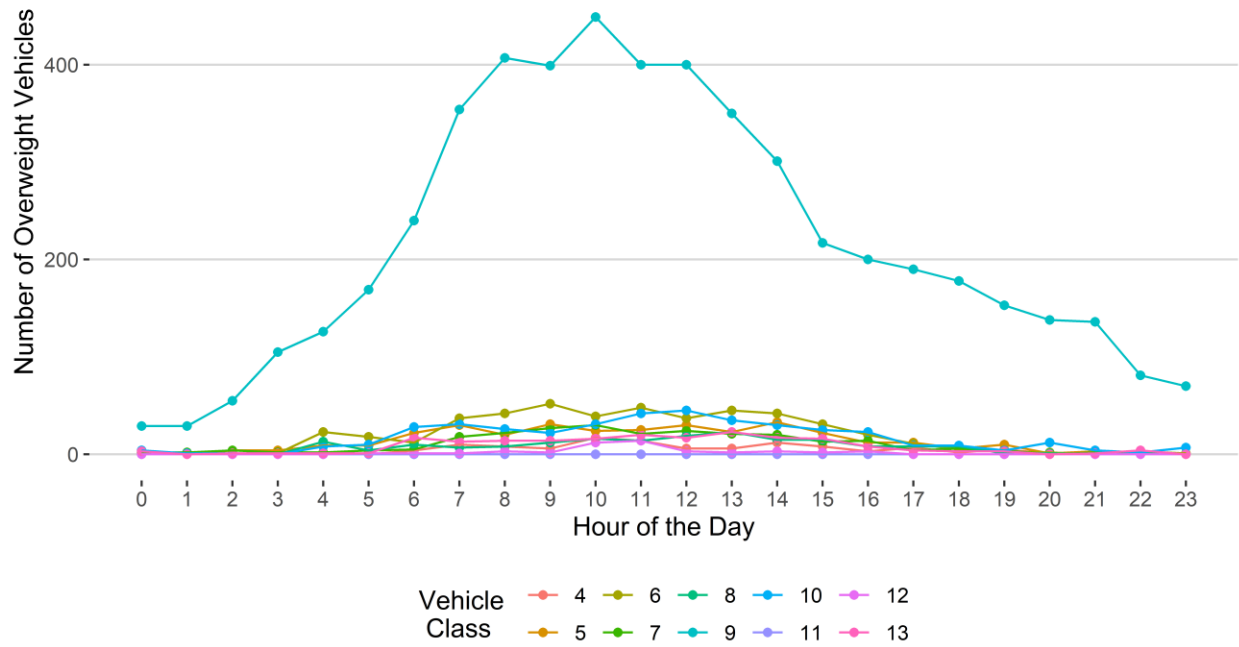


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

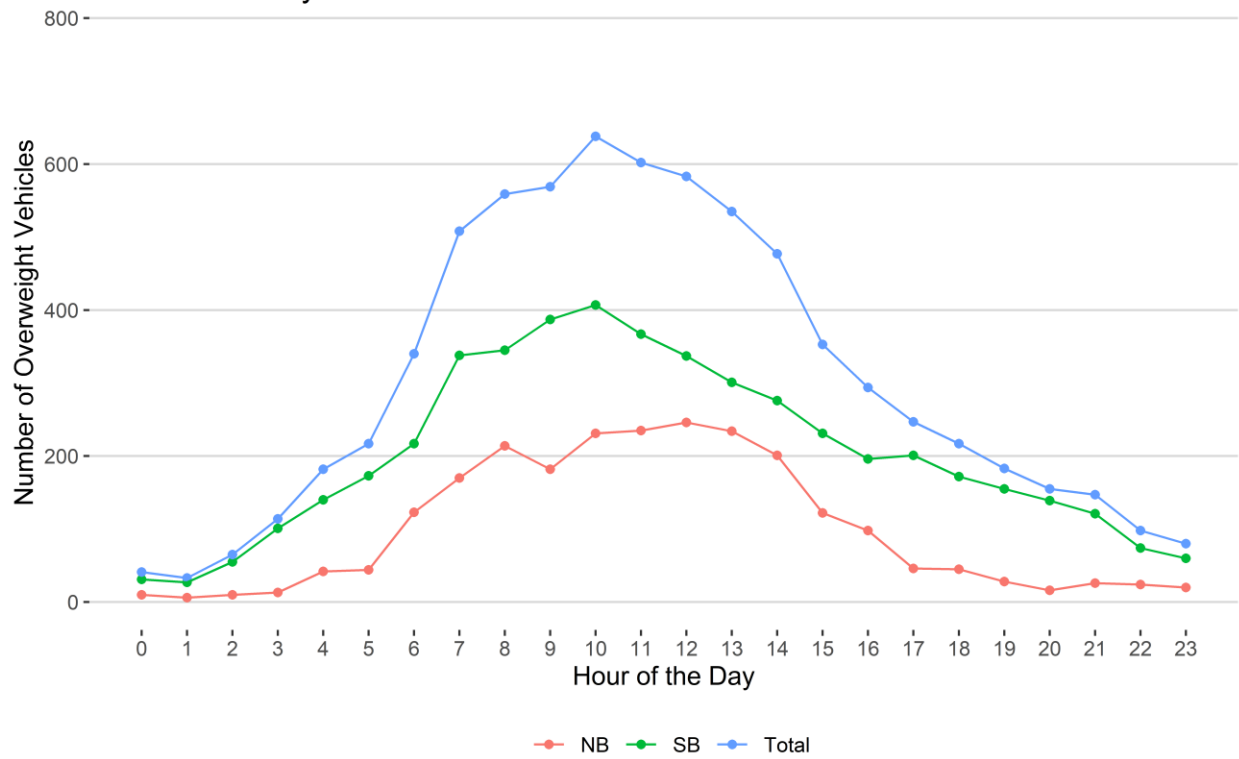
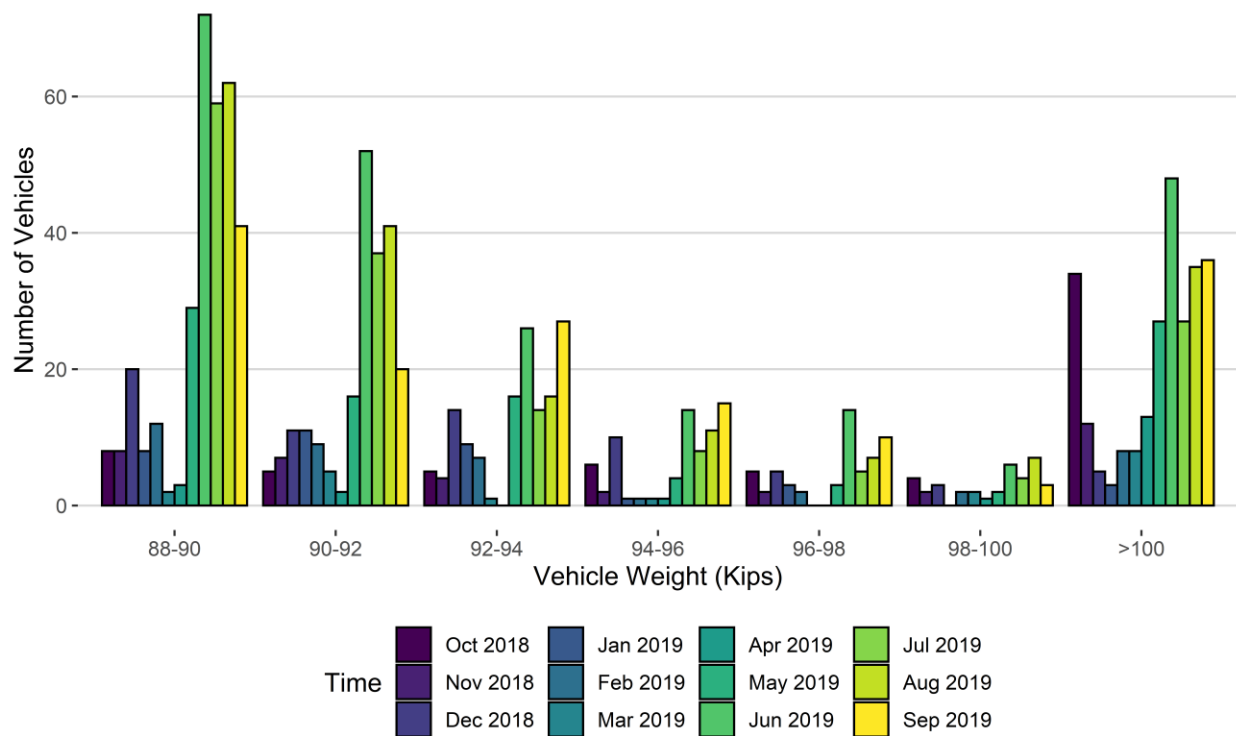
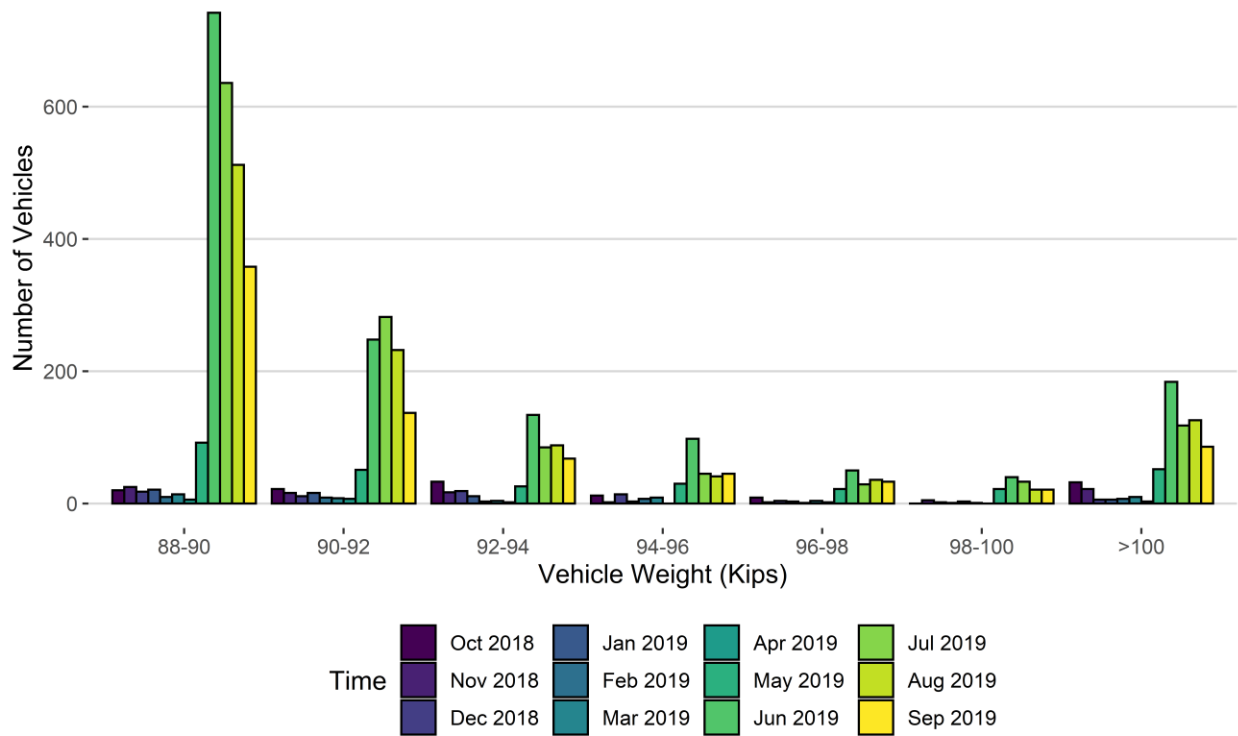


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019
88-90	8	8	20	8	12	2	3	29	72	59	62	41
90-92	5	7	11	11	9	5	2	16	52	37	41	20
92-94	5	4	14	9	7	1	0	16	26	14	16	27
94-96	6	2	10	1	1	1	1	4	14	8	11	15
96-98	5	2	5	3	2	0	0	3	14	5	7	10
98-100	4	2	3	0	2	2	1	2	6	4	7	3
>100	34	12	5	3	8	8	13	27	48	27	35	36
Total	67	37	68	35	41	19	20	97	232	154	179	152

Figure 8 - Histogram of SB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Oct 2018</i>	<i>Nov 2018</i>	<i>Dec 2018</i>	<i>Jan 2019</i>	<i>Feb 2019</i>	<i>Mar 2019</i>	<i>Apr 2019</i>	<i>May 2019</i>	<i>Jun 2019</i>	<i>Jul 2019</i>	<i>Aug 2019</i>	<i>Sep 2019</i>
88-90	20	25	18	21	10	14	6	92	742	636	512	358
90-92	22	16	11	16	9	8	7	51	248	282	232	137
92-94	33	17	19	11	3	4	2	26	134	85	88	68
94-96	12	2	14	3	7	9	0	30	98	45	41	45
96-98	9	2	4	3	1	4	2	22	50	29	36	33
98-100	0	5	2	1	3	1	0	22	40	33	21	21
>100	32	22	6	6	7	10	3	52	184	118	126	86
Total	128	89	74	61	40	50	20	295	1496	1228	1056	748

Figure 8 - Class 9's and 10's by Direction
vs Gross Vehicle Weight

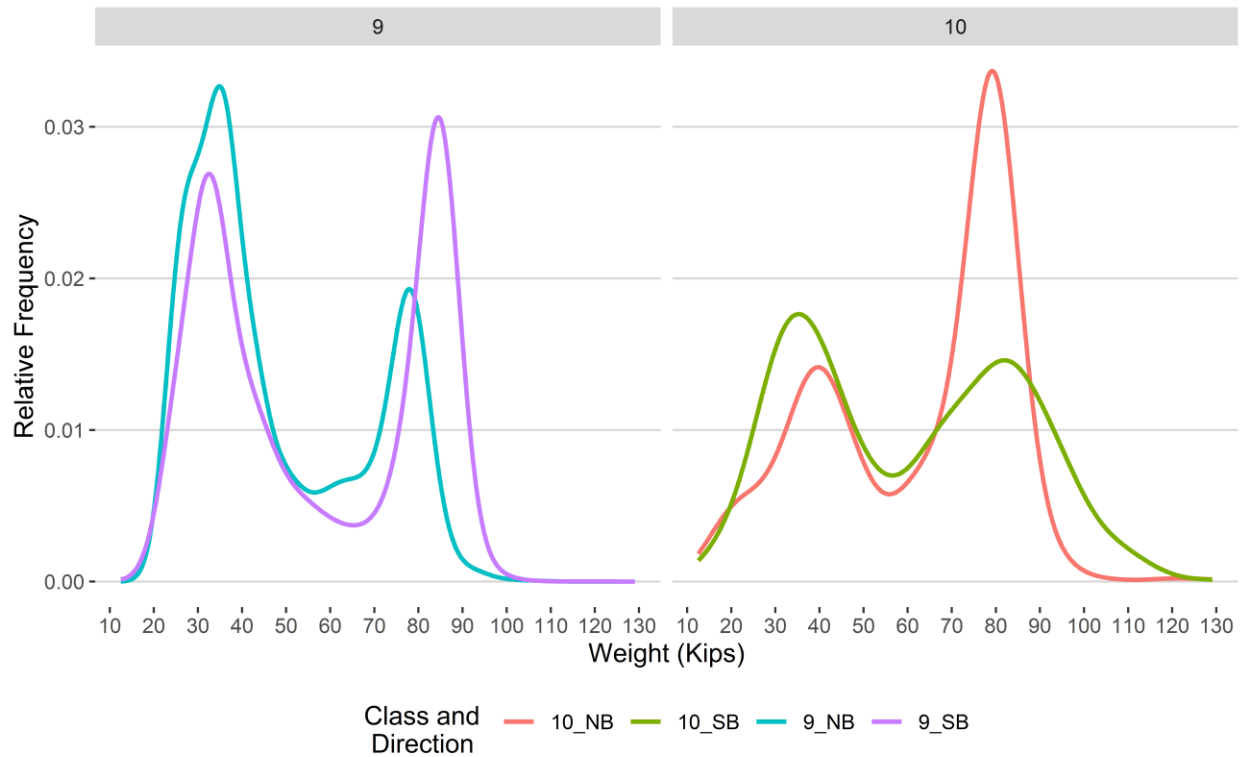


Figure 9 - Freight Percentage
by Direction and Class

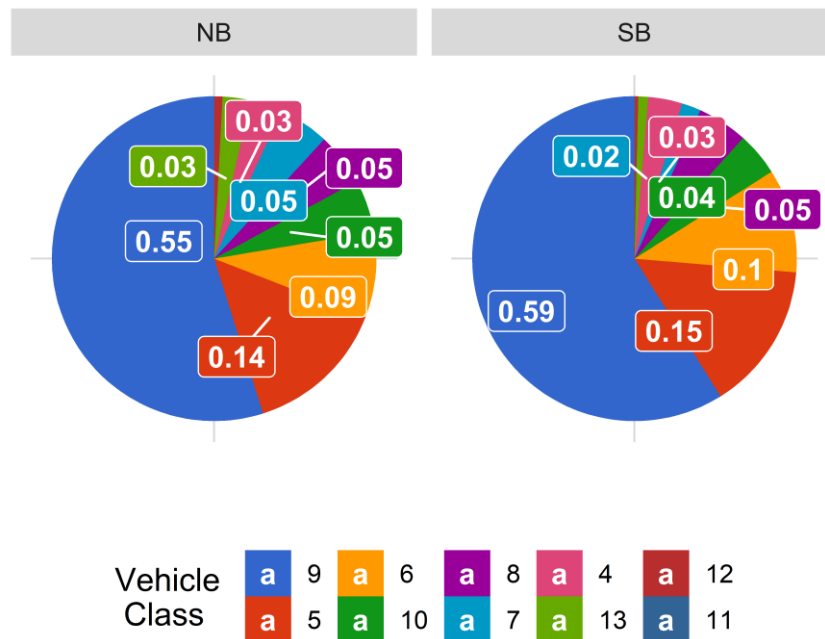


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

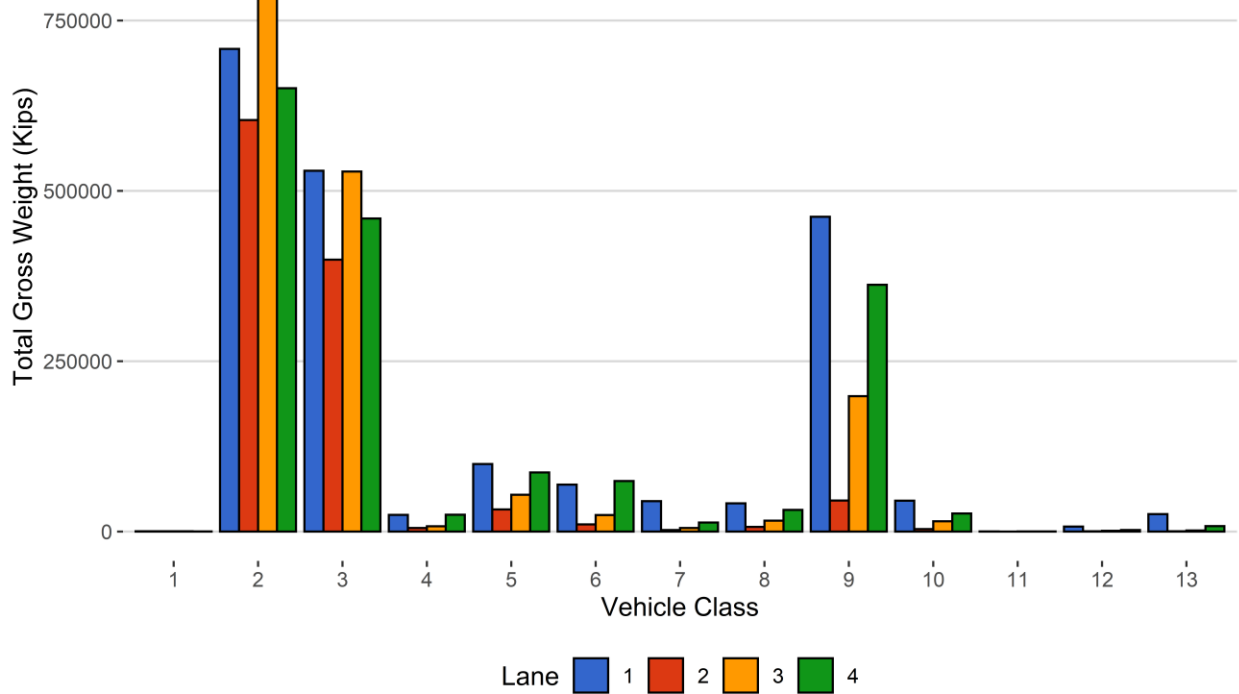


Figure 11 - Total Gross Vehicle Weight t

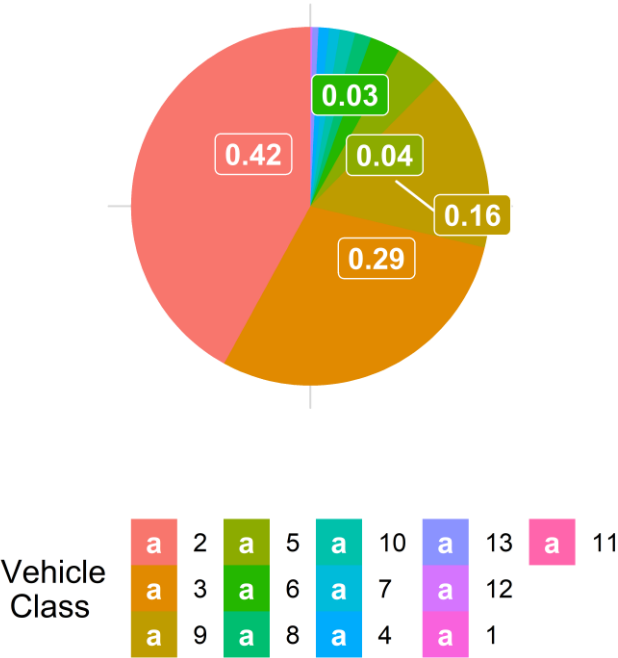


Figure 12 - Total ESALs by Class and Lane

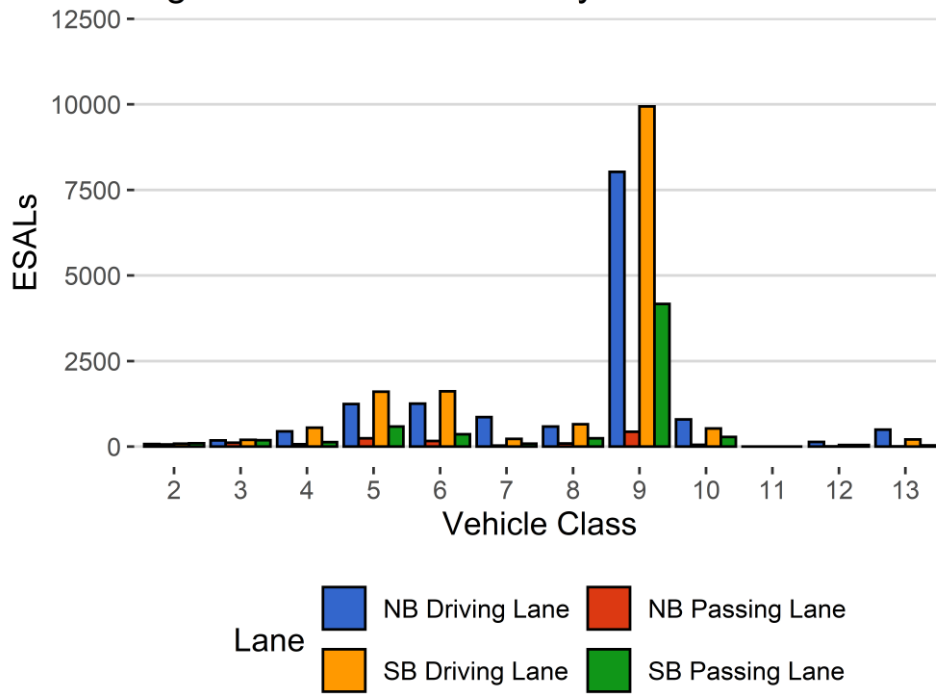


Figure 13 - ESALs by Class

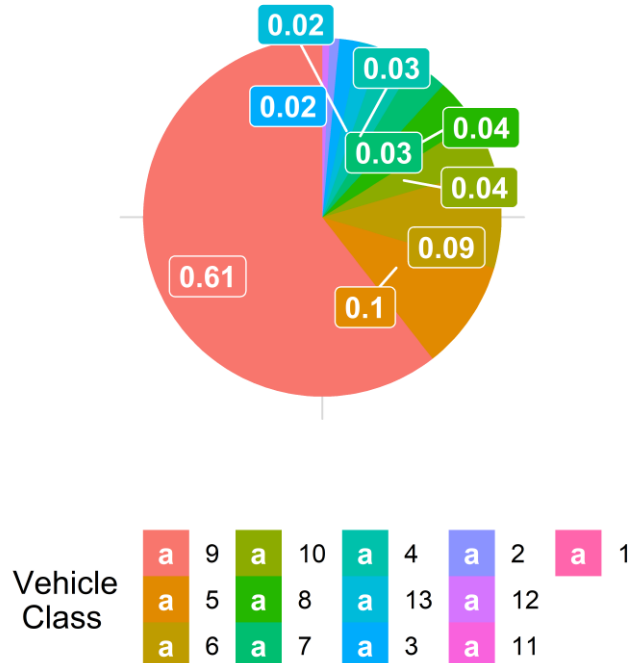


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 3 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 4 (kips)</i>	<i>Front Axle +/- 9%</i>
June 2019	10.72	0.00	10.57	0.00	11.19	0.00	11.79	0.00
July 2019	10.75	0.31	10.61	0.38	11.12	-0.62	11.91	1.04
August 2019	10.77	0.46	10.56	-0.06	10.92	-2.39	11.81	0.17
September 2019	10.71	-0.14	10.45	-1.16	11.04	-1.34	11.74	-0.41

Table 2 Vehicle Classification Data

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	34	1031	0.1	0	0
2	23464	703925	65.3	0	0
3	10656	319679	29.6	0	0
4	68	2043	0.2	112	1.6
5	637	19102	1.8	335	4.7
6	192	5755	0.5	474	6.6
7	35	1041	0.1	249	3.5
8	106	3177	0.3	183	2.5
9	698	20935	1.9	5176	72.1
10	50	1506	0.1	409	5.7
11	0	13	0	0	0
12	5	158	0	47	0.7
13	14	430	0	197	2.7
TOTAL	35960	1078795	100	7182	100

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2019-09-25	Wednesday	13:43:21	10	SB	4	129.1
2019-09-17	Tuesday	16:52:00	10	NB	1	128.72
2019-09-04	Wednesday	16:08:25	9	SB	4	122.71
2019-09-27	Friday	10:48:27	10	NB	1	121.96
2019-09-23	Monday	01:05:09	10	NB	1	117.94
2019-09-18	Wednesday	15:55:26	10	SB	4	117.88
2019-09-06	Friday	23:41:44	9	SB	4	116.57
2019-09-10	Tuesday	12:46:55	10	SB	3	113.88
2019-09-13	Friday	11:35:05	10	SB	4	112.9
2019-09-20	Friday	14:12:28	10	SB	4	112.58

Table 4 Freight Summary

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	NB	15	1014	148	14.6	27611	1874	7311
5	NB	8	9279	1234	13.3	122563	8927	29102
6	NB	19	2568	302	11.8	74062	5007	15504
7	NB	11.5	724	0	0	46658	0	19166
8	NB	31	1644	1051	63.9	23534	24662	2575
9	NB	33	10561	2972	28.1	424459	82996	87011
10	NB	33.5	780	87	11.2	46633	2126	11709
11	NB	36.5	5	4	80	39	77	1
12	NB	36.5	112	0	0	7516	0	1714
13	NB	31.5	321	0	0	25936	0	7912
TOTAL	****	****	27008	5798	****	799012	****	182005
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	SB	15	979	66	6.7	31387	872	8846
5	SB	8	9355	654	7	135662	4809	33027
6	SB	19	3046	181	5.9	95292	3066	20429
7	SB	11.5	291	0	0	18213	0	7433
8	SB	31	1455	631	43.4	33799	13773	4128
9	SB	33	9861	2329	23.6	494342	66331	122893
10	SB	33.5	689	137	19.9	37576	3889	9542
11	SB	36.5	8	4	50	252	94	53
12	SB	36.5	42	1	2.4	3176	26	840
13	SB	31.5	98	0	0	9413	0	3163
TOTAL	****	****	25824	4003	****	859114	****	210354
GRAND TOTAL	****	****	52832	9801	382	1658126	218530	392359

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB Driving Lane</i>	<i>NB Passing Lane</i>	<i>SB Passing Lane</i>	<i>SB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>
1	277	315	392	232	1217	0
2	708301	603917	786312	650459	2748989	42
3	529479	398959	528214	459443	1916095	29.3
4	24374	5112	7659	24600	61745	0.9
5	99007	32483	53910	86562	271962	4.2
6	68737	10333	24214	74145	177428	2.7
7	44506	2152	5071	13142	64871	1
8	41340	6856	15898	31675	95768	1.5
9	461905	45550	198513	362160	1068128	16.3
10	45128	3631	15080	26386	90225	1.4
11	116	0	157	189	462	0
12	7126	390	1108	2094	10717	0.2
13	25473	463	1564	7849	35349	0.5
TOTAL	2055768	1110161	1638093	1738934	6542956	100
GVW/LANE	31.42	16.97	25.04	26.58	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB Driving Lane</i>	<i>NB Passing Lane</i>	<i>SB Passing Lane</i>	<i>SB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0	0	0.001
2	76	66	98	87	326	0.88	0.001
3	180	113	187	197	677	1.82	0.0044
4	449	70	130	551	1200	3.22	1.21
5	1243	243	584	1605	3676	9.86	0.4
6	1259	165	362	1614	3400	9.12	1.21
7	861	31	87	225	1204	3.23	2.37
8	588	91	244	652	1576	4.23	1.02
9	8030	437	4172	9939	22578	60.55	2.21
10	797	51	282	533	1664	4.46	2.26
11	0	0	2	4	6	0.02	0.97
12	136	7	48	46	237	0.63	2.93
13	496	6	36	208	746	2	3.49
TOTAL	14115	1281	6231	15662	37289	100	18
ESALS/LANE	37.9	3.4	16.7	42	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCAD T</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>	<i>Heavy Commercial Vehicles in Driving Lane %</i>	<i>Heavy Commercial Vehicles in Passing Lane %</i>
Oct 2018	1143679	36893	1932	1083787	94.8	59891.9	5.2	73.6	26.4
Nov 2018	980508	32684	1594	932691	95.1	47816.9	4.9	71.4	28.6
Dec 2018	921951	30732	1217	884226	95.9	37725.4	4.1	70.5	29.5
Jan 2019	912085	29422	1247	873418	95.8	38667.4	4.2	72	28
Feb 2019	795365	28406	1230	760938	95.7	34426.8	4.3	67	33
Mar 2019	973223	31394	1336	931796	95.7	41427.3	4.3	71.7	28.3
Apr 2019	1019560	33985	1544	973238	95.5	46322.3	4.5	72.1	27.9
May 2019	1118314	36375	1686	1066053	95.3	52260.7	4.7	71.6	28.4
Jun 2019	1096822	36561	1744	1044498	95.2	52323.8	4.8	70.1	29.9
Jul 2019	1100654	35362	1785	1045333	95	55321.1	5	71.7	28.3
Aug 2019	1121913	36075	1861	1064211	94.9	57701.6	5.1	72.4	27.6
Sep 2019	1078795	36258	1805	1024635	95	54159.7	5	72.2	27.8
TOTAL	12262869	-	-	11684824	-	578045	-	-	-
AVERAGE	1021906	33679	1582	973735	95	48170	5	71	29

###ESALS

<i>Month</i>	<i>ESALS NB Passing Lane</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>ESALS SB Passing Lane</i>	<i>Total ESALS</i>	<i>Driving Lane ESALS %</i>	<i>Passing Lane ESALS %</i>	<i>Pavement Life Decrease Months</i>
Oct 2018	14864	1239	4123	11960	32186	83	17	0.9
Nov 2018	11820	925	3283	9678	25705	84	16	0.7
Dec 2018	9672	743	2777	6999	20190	83	17	2.8
Jan 2019	8504	642	2895	6695	18736	81	19	1.3
Feb 2019	7396	843	2850	4522	15611	76	24	1.9

Mar 2019	8913	920	2731	6292	18856	81	19	0.5
Apr 2019	8652	896	2921	6854	19322	80	20	0.1
May 2019	10529	1103	5184	12002	28819	78	22	6.2
Jun 2019	28564	2771	13156	27126	71617	78	22	2.9
Jul 2019	17750	1504	6355	15850	41459	81	19	3.6
Aug 2019	19834	1591	6030	16437	43893	83	17	3.7
Sep 2019	14251	1288	6245	15698	37482	80	20	16.3
TOTAL	160750	14463	58550	140114	373877	-	-	-
AVERAGE	13396	1205	4879	11676	31156	81	19	3

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Passing Lane</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Passing Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Oct 18	2278157	1216871	1631350	1776223	6902601
Nov 18	1807476	940472	1377348	1453973	5579269
Dec 18	1696068	847600	1282320	1192264	5018252
Jan 19	1596048	784003	1204798	1160173	4745021
Feb 19	1387374	715290	1084749	864793	4052206
Mar 19	1654804	918271	1249463	1251819	5074356
Apr 19	1746072	946867	1329617	1290655	5313211
May 19	1895521	1089661	1663992	1664481	6313656
Jun 19	4148155	2426300	3405678	3123961	13104094
Jul 19	2179409	1266094	1670241	1741373	6857117
Aug 19	2270498	1248079	1680800	1830923	7030299
Sep 19	2061588	1110530	1638803	1740677	6551598
TOTAL	24721169	13510038	19219158	19091315	76541680
AVERAGE	2060097	1125837	1601597	1590943	6378473

###Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Oct 2018	3922	0.3	6.4	195	70
Nov 2018	3672	0.4	7.8	127	42
Dec 2018	2606	0.3	6.9	144	17
Jan 2019	1949	0.2	5.1	96	10
Feb 2019	1628	0.2	4.7	81	20
Mar 2019	1385	0.1	3.4	70	22
Apr 2019	1064	0.1	2.3	40	17
May 2019	4468	0.4	8.8	393	103
Jun 2019	14060	0.7	13.9	1736	282

Jul 2019	8530	0.8	15.7	1384	182
Aug 2019	9199	0.8	16.2	1236	189
Sep 2019	7237	0.7	13.6	900	146
TOTAL	59720	-	-	6402	1100
AVERAGE	4976.7	0.4	8.7	533.5	91.7

###Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Oct 2018	212665	187441	400106	53.2	46.8
Nov 2018	157880	147600	305480	51.7	48.3
Dec 2018	125562	112167	237729	52.8	47.2
Jan 2019	114896	109750	224646	51.1	48.9
Feb 2019	102376	83792	186168	55	45
Mar 2019	125458	111529	236987	52.9	47.1
Apr 2019	129728	127691	257419	50.4	49.6
May 2019	145149	190653	335802	43.2	56.8
Jun 2019	376690	385390	762081	49.4	50.6
Jul 2019	217482	209237	426719	51	49
Aug 2019	238156	208899	447055	53.3	46.7
Sep 2019	182005	210354	392359	46.4	53.6
TOTAL	2128048	2084503	4212551	-	-
AVERAGE	177337.4	173708.6	351045.9	50.9	49.1